



US005336387A

United States Patent [19]

Egen et al.

[11] **Patent Number:** 5,336,387[45] **Date of Patent:** Aug. 9, 1994

[54] **ELECTRICAL SEPARATOR APPARATUS
AND METHOD OF COUNTERFLOW
GRADIENT FOCUSING**

[75] **Inventors:** Ned B. Egen; Garland E. Twitty;
David W. Sammons, all of Tucson,
Ariz.

[73] **Assignee:** BioSeparations, Inc., Tucson, Ariz.

[21] **Appl. No.:** 977,279

[22] **Filed:** Nov. 16, 1992

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 580,959, Sep. 11, 1990,
Pat. No. 5,173,164.

[51] **Int. Cl.⁵** G01N 27/26; G01N 27/447

[52] **U.S. Cl.** 204/301; 204/299 R

[58] **Field of Search** 204/299 R, 301

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,829,370	8/1974	Bourat	204/301 X
3,989,613	11/1976	Gritzner	204/182.3
4,204,929	5/1980	Bier	204/182.3
4,323,439	4/1982	O'Farrell	204/182.6
4,362,612	12/1982	Bier	204/301
4,588,492	5/1986	Bier	204/301
4,673,483	6/1987	Mandle	204/301
4,963,236	10/1990	Rodkey et al.	204/183.2
5,173,164	12/1992	Egen et al.	204/301

OTHER PUBLICATIONS

Ivory, Cornelius F. and Gobie, William A., Continuous

Counteracting Chromatographic Electrophoresis, *Bio-
technology Prog.*, vol. 6, pp. 21-32, 1990.

Egen, N. B., Twitty, G. E., Thormann, W., and Bier,
M., Fluid Stabilization during Isoelectric Focusing in
Cylindrical and Annular Columns, *Separation Science
and Technology*, vol. 22(5), pp. 1383-1403, 1987.

Primary Examiner—John Niebling

Assistant Examiner—John S. Starsiak, Jr.

Attorney, Agent, or Firm—David G. Rosenbaum

[57] **ABSTRACT**

A preparative scale electrical separator, which is matrix-free and may be operated in both a batch mode and a continuous, flow-through mode is provided. It may be scaled according to the solution quantities which are to be processed. An internal cooling system whereby the process fluid is always in close proximity to a chilled surface assures an efficient heat dissipation during the separation and concentration processes and also allows the use of higher voltage gradients and shorter separation times than prior designs of electrophoretic separators. Electroosmotic and convective mixing is reduced by providing internal, compartmentation of sample fractions, focusing is improved and focusing times are decreased. A counter-flow gradient focusing method using the electrophoretic separator allows for separation of cells from human or animal blood and tissues, cells from plants, bacteria and viruses. The counter-flow gradient focusing method employs both a counter-flow in a direction opposite from the electromobility of the charged components and a flow gradient resulting from the withdrawal of a fractional flow unit from each subcompartment in the apparatus.

26 Claims, 7 Drawing Sheets

